

THE EFFECTS OF OIL AND  
DISPERSED OIL ON THREE  
TEMPERATE AUSTRALIAN  
SEAGRASSES – SCALING OF  
POLLUTION IMPACTS

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## **Certificate of Authorship**

I certify that the work in this thesis has not been previously submitted for a degree nor has it been submitted as part of the requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Kenn Wilson

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## Abstract

The thesis is a comprehensive assessment of the effects of oil and dispersed oil on subtidal seagrass using a range of *in situ* and laboratory experiments on whole plants and seagrass leafblade sections. Apart from assessing the effects of oil and dispersed oil on seagrass between seasons, locations, and morphologically different species, the study determines whether laboratory results are indicative of those obtained *in situ* as an initial step in developing a rapid laboratory testing protocol for seagrass assessment. Petrochemical treatments, consisting of a range of concentrations of the water accommodated fraction (WAF) of oil alone (Tapis crude, IFO-380), dispersant alone (Corexit 9527, Ardox, Slickgone, Corexit 9500) and dispersed oil were exposed to whole plants, in both the laboratory and *in situ*, for ten hours followed by a four day recovery period, and for five hours in the leafblade experiments. Photosynthetic health was monitored by assessing the effective quantum yield of photosystem II ( $\Delta F/F_m'$ ) and chlorophyll *a* pigment concentrations, whilst semi-quantitative methods of total petroleum hydrocarbon (TPH) concentration were used to determine the percent TPH remaining in the water column following the exposure period.

In most cases, the non-dispersed oils, Tapis crude oil and IFO-380, had less of an impact to both *Zostera capricorni* and *Halophila ovalis* than the dispersed oil treatments, whilst *Zostera muelleri* did not show any negative impact from either dispersed or non-dispersed Tapis crude oil. Winter *in situ* experiments found slightly greater reductions of  $\Delta F/F_m'$  in *Z. capricorni* in most treatments compared with summer *in situ*, but generally there was minimal impact whilst *Z. muelleri* exhibited a stimulatory response to both non-dispersed and dispersed Tapis crude oil in Corio Bay, Victoria (summer *in situ* only). Laboratory whole plant experiments found *Z. capricorni* was for the most part less resilient to Tapis crude oil (non-dispersed and dispersed) treatments than *Halophila ovalis* whereas, with exposure to IFO-380 (non-dispersed and dispersed) *H. ovalis* was less resilient than *Z. capricorni*. Quite severe, and, or prolonged, photosynthetic stress was evident in both *Z. capricorni* and *H. ovalis* when exposed to most of the dispersant alone treatments (Corexit 9527, Ardox and Corexit

9500), however the Slickgone alone treatment caused only a very short-lived stress response in *H. ovalis* only. The results of the laboratory whole plant experiments, conducted under Sydney summer water temperature conditions, were generally more similar to those observed in the summer *in situ* experiments than those observed in winter *in situ*. The effects to the leafblades of *Z. capricorni* were commonly greater than those observed in the whole plant experiments, even within the short exposure period.  $\Delta F/F_m'$  appeared a more reliable indicator than that achieved with the chlorophyll *a* pigment analyses. Large differences in the percent TPH recovered between *in situ* and laboratory experiments suggests microbial activity and sediments play a substantial role in the partitioning of oils in these experiments. This research suggests that assessments of seagrass health in laboratory experiments can in some cases be representative of that observed *in situ* when similar experimental conditions are maintained. The increased sensitivity of leafblade sections is considered beneficial when rapid comparisons of different petrochemical impacts to seagrass are required, i.e. once an oil spill has occurred.

Table of Contents

Certificate of Authorship.....II

Acknowledgements..... III

Abstract ..... V

Table of Contents..... VII

List of Figures..... X

List of Tables.....XVIII

List of Abbreviations .....XXV

1 Introduction..... 2

1.1 Seagrass ..... 3

1.1.1 Seagrass Biology .....4

1.1.2 Habitat Requirements ..... 6

1.1.3 Value of Seagrass .....7

1.1.4 Seagrass Declines .....9

1.1.5 Threats to Seagrass ..... 9

1.1.6 Recovery of Seagrass..... 11

1.2 Oil..... 13

1.2.1 Crude oil..... 15

1.2.2 Fuel oil ..... 17

1.2.3 Weathering of Spilt Oils ..... 18

1.3 Oil Spill Mitigation..... 18

1.3.1 Leaving the oil to break down naturally .....20

1.3.2 Chemically dispersing the oil ..... 23

1.3.3 Net Environmental Benefit Analysis ..... 26

1.4 Oil Spill Research and Subtidal Seagrass ..... 28

1.4.1 Effects of non- dispersed oil on seagrass ..... 28

1.4.2 Effects of dispersed oil on seagrass ..... 30

1.4.3 Disparity in research findings ..... 32

1.4.4 Field compared with laboratory experiments..... 32

1.4.5 Application of a rapid laboratory testing protocol ..... 33

1.5	Significance of this study.....	34
1.6	Aims.....	35
2	General Methods.....	36
2.1	Field Sites.....	36
2.2	Seagrass Methods.....	38
2.2.1	Seagrass collection & culturing.....	38
2.2.2	Description of seagrass species .....	40
2.2.3	Chlorophyll <i>a</i> fluorescence .....	42
2.3	Oil Description, Preparation and Analysis .....	44
2.3.1	Description of oils and dispersants .....	44
2.3.2	Preparation of the water accommodated fraction (WAF).....	45
2.3.3	Chemical analysis of the water accommodated fraction .....	47
2.4	Statistical Analysis .....	54
3	Impacts of Petrochemicals <i>In Situ</i> .....	56
3.1	Introduction.....	56
3.2	Methods .....	58
3.3	Results.....	64
3.3.1	Tapis crude oil: non-dispersed, dispersed and dispersant alone.....	64
3.3.2	IFO-380: non-dispersed, dispersed and dispersant alone .....	78
3.4	Discussion.....	87
4	Impacts of Petrochemicals in Laboratory Experiments .....	93
4.1	Introduction.....	93
4.2	Methods .....	95
4.3	Results.....	98
4.3.1	Tapis crude oil: non-dispersed, dispersed and dispersant alone.....	98
4.3.2	<i>Total petroleum hydrocarbon (TPH) concentration</i> .....	98
4.3.3	IFO-380: non-dispersed, dispersed and dispersant alone .....	117
4.4	Discussion.....	135
4.4.1	Tapis crude oil: non-dispersed, dispersed and dispersant alone.....	135
4.4.2	IFO-380: non-dispersed, dispersed and dispersant alone .....	137
4.5	General Conclusions.....	140
5	Development of a Laboratory Testing Protocol .....	144



5.1	Introduction.....	144
5.2	Methods .....	146
5.3	Results.....	147
5.3.1	Tapis crude oil: non-dispersed, dispersed and dispersant alone.....	147
5.3.2	IFO-380 oil: non-dispersed, dispersed and dispersant alone .....	158
5.4	Discussion.....	168
6	General Discussion.....	173
6.1	Summary of Field and Laboratory Results .....	173
6.2	Replication of Results Between Field and Laboratory.....	187
6.3	Representative of Real Spill Conditions? .....	190
6.4	Was the Testing Protocol Useful? .....	192
6.5	Future Research.....	193
6.6	Conclusions.....	197
	Appendix: Final Report to the Australian Maritime Safety Authority .....	198
	References .....	225



## List of Figures

Figure 1.1: Schematic diagram of the weathering processes and fate of spilled oil in the marine environment (www.itopf.com).....	19
Figure 1.2: Diagram showing the timeline and relative importance of the weathering processes of spilled oil in the marine environment (adapted from Clark 2002).....	19
Figure 2.1: Location of Bonna Point in Botany Bay, New South Wales; and Corio Bay in Port Phillip Bay, Victoria; Australia. ....	39
Figure 2.2: Map showing distribution and composition of seagrass, saltmarsh and mangrove habitats along the southern side of Botany Bay, Sydney and the general location of the Towra Point Aquatic Reserve of RAMSAR significance (Adapted from Creese <i>et al.</i> 2009).....	40
Figure 2.3: Images of the seagrass species investigated in this study; a) <i>Zostera capricorni</i> , b) <i>Zostera muelleri</i> , and c) <i>Halophila ovalis</i> . ....	43
Figure 2.4: Carbon chain length fractionation per treatment and total petroleum hydrocarbon concentration ( $\text{mg L}^{-1}$ ) within the crude, crude + Corexit 9527, Crude + Ardrex, Corexit 9527 alone, Ardrex alone WAF treatments pre-exposure ( $n = 1$ )....	49
Figure 2.5: BTEX composition ( $\text{mg L}^{-1}$ ) within the crude, crude + Corexit 9527, Crude + Ardrex, Corexit 9527 alone, Ardrex alone WAF treatments pre-exposure ( $n = 1$ ). ....	49
Figure 2.6: Carbon chain length fractionation per treatment and total petroleum hydrocarbon concentration ( $\text{mg L}^{-1}$ ) within the IFO-380, IFO-380 + Slickgone, IFO-380 + Corexit 9500, Slickgone alone and Corexit 9500 alone WAF treatments pre-exposure ( $n = 1$ ).....	52
Figure 2.7 BTEX composition ( $\text{mg L}^{-1}$ ) within the IFO-380, IFO-380 + Slickgone, IFO-380 + Corexit 9500, Slickgone alone and Corexit 9500 alone WAF treatments pre-exposure ( $n = 1$ ). ....	53
Figure 3.1: Photo of mesocosms in the seagrass meadows of Corio Bay, Port Phillip Bay, Victoria.....	59
Figure 3.2: Schematic diagram showing the positioning of the seagrass blade in the leaf clip and the fibre optic (not to scale).....	60

Figure 3.3: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of Tapis crude oil over the exposure and recovery days in summer. Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	67
Figure 3.4: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of Tapis crude oil over the exposure and recovery days in winter. Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	67
Figure 3.5: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of Tapis crude oil and C9527 over the exposure and recovery days in summer. Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	68
Figure 3.6: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of Tapis crude oil and C9527 over the exposure and recovery days in winter. Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	68
Figure 3.7: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of C9527 over the exposure and recovery days in summer. Percent change from control. Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	69
Figure 3.8: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of C 9527 over the exposure and recovery days in winter. Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	69
Figure 3.9: Change in effective quantum yield of <i>Z. muelleri</i> exposed to the water accommodated fraction (WAF) of Tapis crude oil over the exposure and recovery days in summer in Corio Bay (VIC). Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	70
Figure 3.10: Change in effective quantum yield of <i>Z. muelleri</i> exposed to the water accommodated fraction (WAF) of Tapis crude oil and Corexit© 9527 over the exposure and recovery days in summer in Corio Bay (VIC). Time zero is pre-petrochemical exposure. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). ..	71

Figure 3.11: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of IFO-380 over the exposure and recovery days in summer. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	80
Figure 3.12: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of IFO-380 over the exposure and recovery days in winter. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	80
Figure 3.13: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of IFO-380 and Slickgone over the exposure and recovery days in summer. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	81
Figure 3.14: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of IFO-380 and Slickgone over the exposure and recovery days in winter. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	81
Figure 3.15: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of Slickgone over the exposure and recovery days in summer. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	82
Figure 3.16: Change in effective quantum yield of <i>Z. capricorni</i> exposed to the water accommodated fraction (WAF) of Slickgone over the exposure and recovery days in winter. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	83
Figure 4.1: Photo of tank set-up for the whole plant laboratory exposure experiments. N.B. Tank lids have been removed. ....	96
Figure 4.2 Percentage TPH remaining after ten hours exposure determined by Ultra-violet fluorescence for the Tapis crude oil, Tapis crude oil + C9527; Tapis crude oil + Ardrex; C9527 and Ardrex WAF treatments (* denotes a significant difference between the pre- and post concentrations. Average $\pm$ standard error of the mean are shown ( $n=3$ ).....	100



Figure 4.3: Change in effective quantum yield of <i>Z. capricorni</i> exposed to different concentrations of the water soluble fraction of Tapis crude oil. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 102	102
Figure 4.4: Change in effective quantum yield of <i>Z. capricorni</i> exposed to different concentrations of the water soluble fraction of Tapis crude oil and Corexit 9527. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 102	102
Figure 4.5: Change in effective quantum yield of <i>Z. capricorni</i> exposed to different concentrations of the water soluble fraction of Tapis crude oil and Ardrex. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 104	104
Figure 4.6: Change in effective quantum yield of <i>Z. capricorni</i> exposed to different concentrations of the water soluble fraction of Corexit 9527. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 105	105
Figure 4.7: Change in effective quantum yield of <i>Z. capricorni</i> exposed to different concentrations of the water soluble fraction of Ardrex. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 105	105
Figure 4.8: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of Tapis crude oil. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 110	110
Figure 4.9: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of Tapis crude oil and Corexit 9527. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 110	110
Figure 4.10: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of Tapis crude oil and Ardrex. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 111	111
Figure 4.11: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of Corexit 9527. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 113	113

Figure 4.12: Change in effective quantum yield of *H. ovalis* exposed to different concentrations of the water soluble fraction of Ardrox. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 113

Figure 4.13: Percentage TPH remaining after ten hours exposure determined by UV fluorescence for IFO-380, IFO-380 + Slickgone; IFO-380 + Corexit 9500 (C9500); Slickgone and Corexit 9500 WAF treatments (\* denotes a significant difference between the pre- and post concentrations Average  $\pm$  standard error of the mean are shown ( $n = 3$ )). 118

Figure 4.14: Change in effective quantum yield of *Z. capricorni* exposed to different concentrations of the water soluble fraction of IFO-380. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 120

Figure 4.15: Change in effective quantum yield of *Z. capricorni* exposed to different concentrations of the water soluble fraction of IFO-380 and Slickgone. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 121

Figure 4.16: Change in effective quantum yield of *Z. capricorni* exposed to different concentrations of the water soluble fraction of IFO-380 and Corexit 9500. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 121

Figure 4.17: Change in effective quantum yield of *Z. capricorni* exposed to different concentrations of the water soluble fraction of Slickgone. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 123

Figure 4.18: Change in effective quantum yield of *Z. capricorni* exposed to different concentrations of the water soluble fraction of Corexit 9500. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 123

Figure 4.19: Change in effective quantum yield of *H. ovalis* exposed to different concentrations of the water soluble fraction of IFO-380. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 127

Figure 4.20: Change in effective quantum yield of *H. ovalis* exposed to different concentrations of the water soluble fraction of IFO-380 and Slickgone. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n = 3$ ). 128



Figure 4.21: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of IFO-380 and Corexit 9500. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	129
Figure 4.22: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of Slickgone Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 130	130
Figure 4.23: Change in effective quantum yield of <i>H. ovalis</i> exposed to different concentrations of the water soluble fraction of Corexit 9500. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). 131	131
Figure 5.1: Percent TPH remaining of the water accommodated fraction following five hours laboratory exposure of Tapis crude oil alone, Tapis crude oil + Corexit 9527, Tapis crude oil + Ardrex, Corexit 9527 alone and Ardrex alone. Averages $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	150
Figure 5.2: Change in effective quantum yield of <i>Z. capricorni</i> leafblade section exposed to the water accommodated fraction (WAF) of Tapis crude oil. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	151
Figure 5.3: Change in effective quantum yield of <i>Z. capricorni</i> leafblade section exposed to the water accommodated fraction (WAF) of Tapis crude oil dispersed with Corexit 9527. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	152
Figure 5.4: Change in effective quantum yield of <i>Z. capricorni</i> leafblade section exposed to the water accommodated fraction (WAF) of Tapis crude oil dispersed with Ardrex. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	152
Figure 5.5: Change in effective quantum yield of <i>Z. capricorni</i> leafblade section exposed to the water accommodated fraction (WAF) of Corexit 9527. Time zero is pre-petrochemical exposure. Average $\pm$ standard error of the mean are shown ( $n = 3$ ). .....	153

Figure 5.6: Change in effective quantum yield of *Z. capricorni* leafblade section exposed to the water accommodated fraction (WAF) of Ardrox. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n=3$ ). 153

Figure 5.7: Percent TPH remaining of the water accommodated fraction following ten hours laboratory exposure of IFO-380 alone, IFO-380 + Slickgone, IFO-380 + Corexit 9500, Slickgone alone and Corexit 9500 alone. Average  $\pm$  standard error of the mean are shown ( $n=3$ ). ..... 159

Figure 5.8: Change in effective quantum yield of *Z. capricorni* leafblade section exposed to the water accommodated fraction (WAF) of IFO-380. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n=3$ ). 161

Figure 5.9: Change in effective quantum yield of *Z. capricorni* leafblade section exposed to the water accommodated fraction (WAF) of IFO-380 dispersed with Slickgone LTSW. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n=3$ )...... 162

Figure 5.10: Change in effective quantum yield of *Z. capricorni* leafblade section exposed to the water accommodated fraction (WAF) of IFO-380 dispersed with Corexit 9500. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n=3$ ). ..... 162

Figure 5.11: Change in effective quantum yield of *Z. capricorni* leafblade section exposed to the water accommodated fraction (WAF) of Slickgone. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n=3$ ). 163

Figure 5.12: Change in effective quantum yield of *Z. capricorni* leafblade section exposed to the water accommodated fraction (WAF) of Corexit 9500. Time zero is pre-petrochemical exposure. Average  $\pm$  standard error of the mean are shown ( $n=3$ ). ..... 164

Figure 1: Carbon chain length fractionation per treatment and total petroleum hydrocarbon concentration ( $\text{mg L}^{-1}$ ) within the crude, crude + Corexit 9527, Crude + Ardrox 6120, Corexit 9527 alone, Ardrox 6120 alone WAF treatments pre-exposure ( $n=1$ ). ..... 223

Figure 2: BTEX composition ( $\text{mg L}^{-1}$ ) within the crude, crude + Corexit 9527, Crude + Ardrox 6120, Corexit 9527 alone, Ardrox 6120 alone WAF treatments pre-exposure ( $n=1$ ). ..... 223

Figure 3: Carbon chain length fractionation per treatment and total petroleum hydrocarbon concentration ( $\text{mg L}^{-1}$ ) within the IFO-380, IFO-380 + Slickgone LTSW, IFO-380 + Corexit 9500, Slickgone LTSW alone and Corexit 9500 alone WAF treatments pre-exposure ( $n = 1$ ). ..... 224

Figure 4: BTEX composition ( $\text{mg L}^{-1}$ ) within the IFO-380, IFO-380 + Slickgone LTSW, IFO-380 + Corexit 9500, Slickgone LTSW alone and Corexit 9500 alone WAF treatments pre-exposure ( $n = 1$ ). ..... 224



## List of Tables

Table 1.1: Damage levels and recovery of seagrass ecosystems following disturbance (Adapted from Zieman <i>et al.</i> 1984). .....	13
Table 1.2: Oil spill incidents in Australian waters (+ indicates at least the stated volume was spilt). (adapted from Nelson 2000; <a href="http://www.amsa.gov.au">www.amsa.gov.au</a> ).....	15
Table 1.3: Characteristics and examples of the different molecular weight components within crude oil (adapted from API 1999). .....	17
Table 2.1: PAH constituents naphthalene and phenanthrene concentrations ( $\mu\text{g L}^{-1}$ ) within the crude, crude + Corexit 9527, Crude + Ardrox, Corexit 9527 alone, Ardrox alone, IFO-380, IFO-380 + Slickgone, IFO-380 + Corexit 9500, Slickgone alone and Corexit 9500 alone WAF pre-exposure. N.B. change of units compared to Figs 2.2, 2.3, 2.4 & 2.5. ....	51
Table 3.1: Percent TPH remaining following 10 hour field exposure of the water accommodated fraction (WAF) of Tapis crude oil alone, and Tapis crude oil dispersed with Corexit 9527 in summer and winter in Botany Bay, New South Wales, and Corio Bay, Victoria. ....	64
Table 3.2: Repeated measures ANOVA for the $\Delta F/F_m'$ data of <i>Z. capricorni</i> exposed to the different concentrations of a) Tapis crude oil alone, b) Tapis crude oil + Corexit 9527 (C9527) and c) Corexit 9527 alone treatments in summer and winter in Botany Bay, New South Wales. Degrees of freedom for interaction were exposure = 20.8, recovery = 22; for time effect exposure = 6, recovery = 7; and for concentration effect exposure = 4, recovery = 4. Bold denotes significant difference at $P = 0.05$ .....	73
Table 3.3: One way analysis of variance (ANOVA) of $\Delta F/F_m'$ of <i>Z. capricorni</i> exposed to the Tapis crude oil alone, Tapis crude oil + Corexit 9527 (C9527) and Corexit 9527 (C9527) alone treatments in summer and winter at each sampling time in Botany Bay, New South Wales. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text. nc denotes ANOVA not calculated (no significant difference in the rmANOVA - Table 3.1). ....	74
Table 3.4: Repeated measures ANOVA for the $\Delta F/F_m'$ data of <i>Z. muelleri</i> exposed to the different concentrations of Tapis crude oil alone and Tapis crude oil + Corexit 9527 (C9527) in Corio Bay, Victoria, in summer. Degrees of freedom for interaction were	

exposure = 20.8, recovery = 22; for time effect exposure = 6, recovery = 7; and for concentration effect exposure = 4, recovery = 4.....	75
Table 3.5: One way analysis of variance (ANOVA) of $\Delta F/ F'_m$ of <i>Z. muelleri</i> exposed to the Tapis crude oil alone and Tapis crude oil + Corexit 9527 (C9527) treatments in Corio Bay, Victoria, in summer at each sampling time. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text. ....	75
Table 3.6: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in <i>Z. capricorni</i> exposed to Tapis crude oil, Tapis crude oil + C9527 and C9527 alone in Botany Bay, New South Wales. Values in bold denote significant difference ( $P < 0.05$ ); values with the same numbers are similar. Averages $\pm$ SE of the mean are shown ( $n=3$ ). ....	76
Table 3.7: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in <i>Z. muelleri</i> exposed to Tapis crude oil and Tapis crude oil + C9527 in Corio Bay, Victoria. Values in bold denote significant difference ( $P < 0.05$ ); values with the same numbers are similar. Averages $\pm$ SE of the mean are shown ( $n=3$ ). ....	77
Table 3.8: Percent TPH remaining following 10 hour field exposure of the water accommodated fraction (WAF) of IFO-380 alone, and IFO-380 dispersed with Corexit 9527 in summer and winter in Botany Bay, New South Wales. ....	78
Table 3.9: Repeated measures ANOVA of the effective quantum yield data of <i>Z. capricorni</i> exposed to the IFO-380 alone, IFO-380 + Slickgone LTSW and Slickgone LTSW alone treatments in summer and winter. Degrees of freedom for interaction were exposure = 20.8, recovery = 22; for concentration effect exposure = 4, recovery = 4; and for time effect exposure = 6, recovery = 7. Bold denotes significant difference at $P = 0.05$ . ....	84
Table 3.10: One way analysis of variance (ANOVA) of $\Delta F/ F'_m$ of <i>Z. capricorni</i> exposed to the IFO-380 alone, IFO-380 + Slickgone and Slickgone alone treatments in summer and winter at each sampling time. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text. nc denotes ANOVA not calculated (no significant difference in the rmANOVA - Table 3.5). ....	85



Table 3.11: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in <i>Z. capricorni</i> exposed to IFO-380, IFO-380 + Slickgone and Slickgone alone at ten hours and 96 hours in summer and winter. Values in bold denote significant difference at $P = 0.05$ ; values with the same numbers are similar. Averages $\pm$ SE of the mean are shown ( $n=3$ ). .....	86
Table 4.1 Independent <i>t</i> test analysis of the total hydrocarbon concentration following ten hours exposure of Tapis crude oil alone; Tapis crude oil + Corexit 9527 (C9527); Tapis crude oil + Ardrox; C9527 alone and Ardrox alone WAF treatments. Values in bold denote significant differences at $P = 0.05$ . .....	101
Table 4.2: Repeated measures ANOVA of the effective quantum yield of <i>Z. capricorni</i> exposed to the different concentrations of a) Tapis crude oil alone, b) Tapis crude oil + Corexit 9527, c) Tapis crude oil + Ardrox, Corexit 9527 alone and Ardrox alone. Degrees of freedom for interaction were exposure = 16, recovery = 12; for time effect exposure = 4, recovery = 3; and for concentration effect exposure = 4, recovery = 4. Values in bold denote a significant difference at $P = 0.05$ . .....	106
Table 4.3: One way analysis of variance (ANOVA) of the effective quantum yield of <i>Z. capricorni</i> exposed to the Tapis crude oil, Tapis crude oil + Corexit 9527 (C9527), Tapis crude oil + Ardrox, Corexit 9527 (C9527) alone and Ardrox alone treatments. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text. nc denotes ANOVA not calculated (no significant difference in the RmANOVA- Table 4.3). Values in bold denote a significant difference at $P = 0.05$ . .....	107
Table 4.4: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in <i>Z. capricorni</i> at ten and 96 hours exposed to Tapis crude oil, Tapis crude oil + C 9527, Tapis crude oil + Ardrox, C 9527 alone and Ardrox alone. Values in bold denote significant differences at $p = 0.05$ ; values with same numbers are similar ( $n = 3$ ). .	108
Table 4.5: Repeated measures ANOVA of the effective quantum yield of <i>H. ovalis</i> exposed to the different concentrations of a) Tapis crude oil alone, b) Tapis crude oil + Corexit 9527, c) Tapis crude oil + Ardrox, Corexit 9527 alone and Ardrox alone. Degrees of freedom for interaction were exposure = 16, recovery = 12; for time effect exposure = 4, recovery = 3; and for concentration effect exposure = 4, recovery = 4. Values in bold denote a significant difference at $P = 0.05$ . .....	114

Table 4.6: One way analysis of variance (ANOVA) of the effective quantum yield of <i>H. ovalis</i> exposed to the Tapis crude oil, Tapis crude oil + Corexit 9527 (C9527), Tapis crude oil + Ardrex, Corexit 9527 (C9527) alone and Ardrex alone treatments. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text. nc denotes ANOVA not calculated (no significant difference in the RmANOVA- Table 4.3). Values in bold denote a significant difference at $P = 0.05$ . .....	115
Table 4.7: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in <i>H. ovalis</i> at ten and 96 hours exposed to Tapis crude oil, Tapis crude oil + C9527, Tapis crude oil + Ardrex, C9527 alone and Ardrex alone. Values in bold denote significant differences at $p = 0.05$ ; values with same numbers are similar ( $n = 3$ ). .....	116
Table 4.8 Independent <i>t</i> test analysis of the total hydrocarbon concentration following ten hours exposure of IFO-380 alone; IFO-380 + Slickgone; IFO-380 + Corexit 9500 (C9500); Slickgone and Corexit 9500 (C9500) ( $n = 3$ ). Values in bold denote a significant difference at $P = 0.05$ . .....	119
Table 4.9: Repeated measures ANOVA of the effective quantum yield of <i>Z. capricorni</i> exposed to different concentrations of a) IFO-380 alone, b) IFO-380 + Slickgone, c) IFO-380 + Corexit 9500 (C9500), Slickgone alone and Corexit 9500 (C9500) alone. Degrees of freedom for interaction were exposure = 16, recovery = 12; for time effect exposure = 4, recovery = 3; and for concentration effect exposure = 4, recovery = 4. Values in bold denote a significant difference at $P = 0.05$ . .....	124
Table 4.10: One way analysis of variance (ANOVA) of the effective quantum yield of <i>Z. capricorni</i> exposed to the IFO-380, IFO-380 + Slickgone, IFO-380 + Corexit 9500 (C9500), Slickgone alone and Corexit 9500 (C9500) alone treatments. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text. nc denotes ANOVA not calculated (no significant difference in the RmANOVA- Table 4.3). Values in bold denote a significant difference at $P = 0.05$ . .....	125
Table 4.11 One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in <i>Z. capricorni</i> at ten and 96 hours exposed to IFO-380, IFO-380 + Slickgone, IFO-380 + C9500, Slickgone alone and C9500 alone. Values in bold denote significant differences at $P = 0.05$ ( $n = 3$ ). .....	126



Table 4.12: Repeated measures ANOVA of the effective quantum yield of *Z. capricorni* exposed to the different concentrations of a) IFO-380 alone, b) IFO-380 + Slickgone, c) IFO-380 + C9500, Slickgone alone and C9500 alone. Degrees of freedom for interaction: exposure = 16, recovery = 12; for time effect exposure = 4, recovery = 3; and for concentration effect exposure = 4, recovery = 4. Values in bold denote a significant difference at  $P = 0.05$ . ..... 132

Table 4.13: One way analysis of variance (ANOVA) of the effective quantum yield of *H. ovalis* exposed to the IFO-380, IFO-380 + Slickgone, IFO-380 + Corexit 9500 (C9500), Slickgone alone and Corexit 9500 (C9500) alone treatments. Differences between concentrations were determined using Tukey’s post hoc comparison and are described in the text. nc denotes ANOVA not calculated (no significant difference in the RmANOVA- Table 4.3). Values in bold denote a significant difference at  $P = 0.05$ . ..... 133

Table 4.14: One way analysis of variance (ANOVA) of chlorophyll *a* pigments in *H. ovalis* at ten and 96 hours exposed to IFO-380, IFO-380 + Slickgone, IFO-380 + C9500, Slickgone alone and C9500 alone. Values in bold denote significant differences at  $p = 0.05$  ( $n = 3$ ). ..... 134

Table 5.1: Independent *t* test analysis of the total hydrocarbon concentration pre– and post–exposure of Tapis crude oil alone, Tapis crude oil + C9527, Tapis crude oil + Ardrex, C9527 alone and Ardrex alone WAF treatments. Values in bold denote significant differences at  $P = 0.05$ . ..... 151

Table 5.2: Repeated measures ANOVA for the effective quantum yield data of *Z. capricorni* leafblades exposed to the different concentrations of a) Tapis crude oil alone, b) Tapis crude oil + C9527, c) Tapis crude oil + Ardrex, d) C9527 alone and e) Ardrex alone WAF treatments. Differences between concentrations were determined using Tukey’s post hoc comparison and are described in the text. Values in bold denote significant difference at  $P = 0.05$ . ..... 155

Table 5.3: One-way ANOVA of the effective quantum yield data of *Z. capricorni* exposed to the different concentrations of Tapis crude oil, Tapis crude oil + C9527, Tapis crude oil + Ardrex, Corexit 9527 alone and Ardrex alone WAF treatments. Values in bold denote a significant difference at  $P = 0.05$ . ..... 156

Table 5.4: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments of <i>Z. capricorni</i> leafblade section exposed to Tapis crude oil, Tapis crude oil + C9527, Tapis crude oil + Ardrox, C9527 alone and Ardrox alone. Bold denotes significant difference ( $P < 0.05$ ). Average $\pm$ standard error of the mean ( $n = 3$ ). .....	157
Table 5.5: Independent <i>t</i> test analysis of the total hydrocarbon concentration pre- and post-exposure of IFO-380 alone, IFO-380 + Slickgone, IFO-380 + Corexit 9500, Slickgone alone and Corexit 9500 alone WAF treatments. Values in bold denote significant difference at $P = 0.05$ .....	160
Table 5.6: Repeated measures ANOVA of the effective quantum yield data of <i>Z. capricorni</i> exposed to the different concentrations of a) IFO-380 alone, b) IFO-380 + Slickgone, c) IFO-380 + Corexit 9500 (C-9500), d) Slickgone alone and e) Corexit 9500 alone WAF treatments.....	165
Table 5.7: One way ANOVA of the effective quantum yield data of <i>Z. capricorni</i> exposed to the different concentrations of IFO-380 alone, IFO-380 + Slickgone, IFO-380 + Corexit 9500 (C-9500), Slickgone alone and Corexit 9500 alone WAF treatments. Differences between concentrations were determined using Tukey's post hoc comparison and are described in the text.....	166
Table 5.8: One way analysis of variance (ANOVA) of chlorophyll <i>a</i> pigments in leafblades of <i>Z. capricorni</i> exposed to IFO-380 alone, IFO-380 + Corexit 9500 (C-9500), IFO-380 + Slickgone, Corexit 9500 alone and Slickgone alone. Bold denotes significant difference ( $P < 0.05$ ). Averages $\pm$ standard error of the mean ( $n = 3$ )....	167
Table 6.1: Summary table of magnitude of stress ( $\Delta F/F_m'$ ), timing of impacts and effective concentrations in <i>Z. muelleri</i> , <i>Z. capricorni</i> and <i>H. ovalis</i> from exposure to the Tapis crude oil treatments (non-dispersed, dispersed and dispersant alone). * not significantly different to control. na treatment was not performed under those conditions. See text for further explanation. ....	175
Table 6.2: Summary of magnitude of stress ( $\Delta F/F_m'$ ), timing of impacts and effective concentrations in <i>Z. capricorni</i> and <i>H. ovalis</i> from exposure to the IFO-380 treatments (non-dispersed, dispersed and dispersant alone). * not significantly different to control. na treatment was not performed under those conditions. See text for further explanation. #Tukeys showed no significant difference. ....	186

Table 3 Summary table of magnitude of stress ( $\Delta F/F_m'$ ), timing of impacts and effective concentrations in *Z. muelleri*, *Z. capricorni* and *H. ovalis* from exposure to the crude oil treatments (non-dispersed, dispersed and dispersant alone). \* not significantly different to control. na treatment was not performed under those conditions. See text for further explanation..... 214

Table 4 Summary table of magnitude of stress ( $\Delta F/F_m'$ ), timing of impacts and effective concentrations in *Z. capricorni* and *H. ovalis* from exposure to the IFO-380 treatments (non-dispersed, dispersed and dispersant alone). \* not significantly different to control. na treatment was not performed under those conditions. See text for further explanation..... 215



## List of Abbreviations

AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of Variance
API	American Petroleum Industry
bbl	barrel
BTEX	benzene, toluene, ethylbenzene, xylene
Chl <i>a</i>	Chlorophyll <i>a</i>
cSt	centistoke
$\Delta F/F_m'$	Effective quantum yield of photosystem II
EWG	Environmental Working Group
GC-MS	Gas Chromatography –Mass Spectrometry
HPLC	High Performance Liquid Chromatography
mg L <sup>-1</sup>	milligrams per Litre
NEBA	Net Environmental Benefit Analysis
NOAA	National Oceanic and Atmospheric Association...
OSC	Oil Spill Coordinator
PAH	Polycyclic Aromatic Hydrocarbon
PAM	Pulse Amplitude Modulation
ppm	parts per million
ppt	parts per thousand
PSI	Photosystem I
PSII	Photosystem II
psu	percent salinity unit
rmANOVA	repeated measures Analysis of Variance
TPH	Total Petroleum Hydrocarbons
UV	Ultra-Violet
UVF	Ultra-Violet Fluorescence
WAF	Water Accommodated Fraction
WSF	Water Soluble Fraction
µg L <sup>-1</sup>	micrograms per Litre